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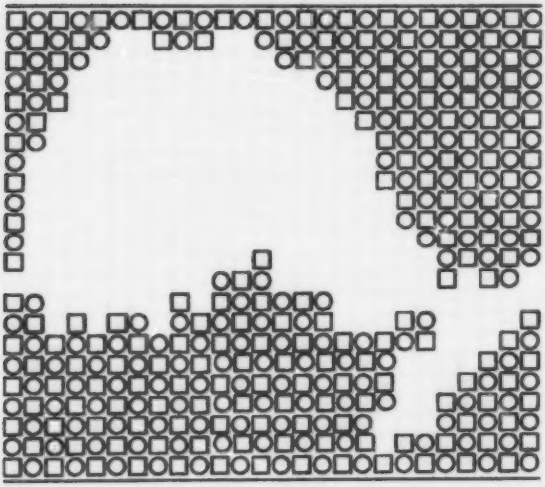
Designated Substances in the Workplace: A General Guide to the Regulations



Designated Substances in the Workplace: A General Guide to the Regulations

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ISBN 0-7794-0752-0 Rev. 03/01

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Introduction

The guide has been prepared to help employers, workers, members of joint health and safety committees, supervisors and occupational health personnel meet the requirements of the designated substance regulations that apply to biological, chemical or physical agents in the workplace, and to understand the responsibilities these regulations place on all participants in a workplace's health and safety system.

The advice in this guide is an interpretation by officials of the Operations Division of the *Occupational Health and Safety Act* (the *Act*) and regulations.

The advice does not have binding effect, but is intended to provide general answers to possible questions asked in the context of a specific fact situation. It is being used by staff of the ministry to assist in the administration of the regulations.

Questions of construction and application will find their ultimate answer given by the courts where a contest ensues as to construction or application of a legislative provision.

The Operations Division of the Ministry of Labour is responsible for administering the *Act*.

One of the major issues facing employers, workers, the division and others is the control of worker exposure to toxic substances in the workplace. The *Act* places duties on employers to take all precautions reasonable in the circumstances to protect the health of workers. Employers are also required to comply with regulations and to provide information, instruction and supervision to workers.

Regulations, made under the *Act*, for industrial establishments, construction projects, mines and mining plants, and health care and residential facilities contain more specific requirements to control toxic substances in each sector. In workplaces outside these sectors, such as schools, the ministry relies upon the general provisions of the *Act*. In many cases the control is achieved by complying with the occupational exposure limits in the Regulation respecting Control of Exposure to Biological or Chemical Agents. Guidelines for worker exposure, such as the Threshold Limit Values and Biological Exposure Indices that are published and updated annually by the American Conference of Governmental Industrial Hygienists, may also be useful for the control of worker exposure to toxic substances.

Another approach used by the ministry has been the development of regulations to control worker exposure to particular toxic substances. These are known as designated substance regulations. A designated substance is defined by the *Act* as a biological, chemical or physical agent or combination of agents for which a regulation has been made to prohibit, regulate, restrict, limit or control worker exposure. At present, each designated substance regulation applies to a single agent or class of agents and sets out requirements governing exposure limits, use of respirators, air monitoring, medical surveillance and record keeping. In the future, as control strategies are reviewed, regulations may apply to broad groups of substances and may not contain all the features of existing designated substance regulations.

At the time of publication there were regulations in place for Acrylonitrile, Arsenic, Asbestos, Asbestos on Construction Projects and in Buildings and Repair Operations, Benzene, Coke Oven Emissions, Ethylene Oxide, Isocyanates, Lead, Mercury, Silica and Vinyl Chloride.

These regulations incorporate a number of approaches to occupational health that were, at the time of their introduction, new to Ontario. Among the most important of these are provisions for an assessment of the likelihood of worker exposure in the

workplace and a control program that includes provisions for engineering controls, work practices, hygiene practices and facilities, air monitoring, record keeping and medical surveillance. The regulations also set limits for the exposure of workers.

A principal feature of the regulations is that the assessment and control programs, where necessary, are to be conducted by an employer in consultation with the joint health and safety committee.

What Information Is in This Guide?

This guide describes general principles for meeting the requirements of the regulations covering the chemical agents that have been designated. The guide includes:

- an overview of the requirements of the regulations;
- a guide to conducting an assessment;
- basic principles for setting up a control program, including information on types of controls, personal protective equipment, air monitoring, record keeping and medical surveillance programs.

Guides for Each Substance

This general guide may be supplemented by separate guides for some of the designated substances. These provide more specific information on:

- application of the regulation;
- exposure limits;
- health effects;
- uses of the substance, and the forms in which it may be present in the workplace;
- the assessment and control program.

In implementing a designated substance regulation, it is important to consult **both** this general guide and the appropriate guide for the specific substance. They alert employers, workers and others to factors that must be considered in assuring that the health of workers is protected. However, they provide only an overview of important principles that must be observed in complying with each requirement of the regulations; they are not intended to provide complete details on all aspects of health hazard control applicable to every situation. It will be necessary, in many cases, for the parties to refer to more detailed references, such as those listed in the back of this guide, or to consult specialists with training and experience in occupational health and hygiene. Other sources of assistance include ministry field offices, Ontario's safe workplace associations, occupational health clinics and training centre, and the Workplace Safety and Insurance Board (addresses are listed in the back of this guide). In addition, private consultants with industrial hygiene expertise may provide services for assessments and development of control programs.

1. An Overview of the Regulations

Who Is Covered by the Regulation?

In most cases, designated substance regulations apply to employers and workers at workplaces where two conditions are met:

- the substance is present in the workplace, and
- a worker is likely to inhale, ingest or absorb some of the substance that is present.

Some of the regulations exempt certain employers and workers from all or part of the regulation. The regulations also differ in their treatment of construction projects. For details on the application of an individual regulation, consult the guide for the appropriate substance.

Who Is Responsible for Implementing the Regulation?

The regulation must be implemented by the employer in consultation with the joint health and safety committee (the committee), which, in most cases, must be established under section 9 of the *Act*. Where a committee is not required by law (see subsections 9 (1) and (2)), the minister may order one to be established.

What Is the Responsibility of the Joint Health and Safety Committee?

Except for workplaces specifically exempted by subsection 9 (1) of the *Act*, a committee is required where a designated substance regulation applies (see clause 9 (2) (c) of the *Act*). For further

details on the general role of committees, consult the ministry's *Guide for Joint Health and Safety Committees and Representatives in the Workplace*. The committee is required as long as the regulation applies to the workplace, even if the assessment discloses that a control program is not necessary. This is so that a committee can continue to monitor the workplace for any changes that might make another assessment necessary.

The employer consults with the committee, which can make recommendations, regarding the development of the assessment and control program. The committee members must be given copies of both the assessment and the control program and must be provided with the results of air sampling tests.

Where a worker has had a medical examination under a regulation-mandated medical surveillance program, the committee receives, on a confidential basis, the examining physician's opinion of whether the worker is fit, fit with limitations or unfit for continued exposure to the substance. Under some regulations, committees would also receive the results and interpretations of clinical tests from the examining physician. The purpose behind this practice is to assist the committee in monitoring the effectiveness of the control program.

What Is the Exposure Limit for the Substance?

Worker exposure to a particular substance must not be greater than the airborne concentration levels prescribed in its regulation. Three types of limits may be specified:

1. The time-weighted average exposure is the average exposure of a worker over the course of a working day and working week. It is calculated on the basis of an 8-hour day and 40-hour week, in accordance with the Schedule in the regulation.

2. The maximum concentration is an exposure level that must not be exceeded at any time. The lead and mercury regulations require that exposure to the maximum concentration shall not:

- exceed 15 minutes at any one time;
- occur more than four times in a work day;
- occur until at least 60 minutes after the last exposure to that concentration.

3. A number of designated substance regulations require employers to reduce exposure to the **lowest practical level**. In such cases, the employer in consultation with the joint health and safety committee, must determine the lowest practical exposure level that can be achieved.

How Is the Lowest Practical Level Determined?

The lowest practical level will depend on the characteristics of the individual worksite. The employer is required to adopt those engineering controls, work practices and hygiene practices that a responsible and prudent employer would put into effect, taking into consideration the plant, equipment, engineering controls and work practices in the workplace, and what can realistically and reasonably be done by way of improvement, modification and replacement.

There are a number of factors that should be considered in determining whether the lowest practical level has been obtained. Some of these factors are:

1) The extent of the health benefits that will likely be obtained from improvements or modifications to existing engineering controls, etc. in the workplace.

2) The exposure levels that were achieved in the worksite in the past.

3) The exposure levels being met in similar worksites.

4) The cost of introducing new engineering controls or of modifying those already in place.

5) The technological feasibility of achieving lower exposure levels.

How Is Exposure Kept Below the Exposure Limits?

The employer must ensure that the exposure of a worker to the substance is within the levels specified by the regulation, by means of:

- engineering controls;
- work practices;
- hygiene practices and facilities.

These types of control measures are described in Chapter 4 of this guide. Specific details of how these controls will be applied must be included in the workplace control program.

Respiratory equipment must not be used to reduce worker exposure below the exposure limit except under the specific conditions outlined in the next section.

When Can Respiratory Equipment Be Used?

In most circumstances an employer must comply with the exposure limits without requiring workers to wear respirators. Before respiratory equipment can be used as a method of compliance, the employer must show that one of the following circumstances exists:

- an emergency: where workers are exposed to immediate danger, such as during a process upset, a spill or equipment breakdown;
- control measures do not exist or are unavailable;
- control measures are not reasonable or practical for the length of time or frequency of exposure or the nature of the process, operation or work;
- control measures are not effective because of a temporary breakdown.

What Is An Assessment and Why Is It Performed?

An assessment is essentially a detailed and methodical examination of the workplace where worker exposure to the designated substance may be occurring. It is performed to determine:

- whether workers are inhaling, ingesting or absorbing the substance at present or whether they are likely to do so in the future; and
- whether or not the health of a worker may be affected by exposure to the substance.

Conclusions reached in the assessment will assist the employer and the joint committee in deciding whether a control program is required. It is therefore important to remember that the assessment must evaluate not only the current state of worker exposure, but potential exposure as well.

The completed assessment must be in the form of a written report, and the employer must give a copy to each member of the committee.

When Is An Assessment Necessary?

An initial assessment is required at every workplace to which the regulation applies. Further assessments are needed whenever there is a change in any process involving the use, handling or storage of the designated substance, if the change may result in a significant difference in a worker's exposure to the substance.

Who Conducts the Assessment?

The employer must ensure that the assessment is carried out and a report prepared. The employer must consult with the committee and receive its recommendations, if any, on the assessment. A team approach is desirable. It should involve the committee, plant personnel familiar with work processes, and if necessary, specialists in occupational health and hygiene.

The employer may, if he or she chooses, contract with a private consultant to perform the assessment. However, the employer remains responsible for ensuring that the assessment is properly conducted, that the committee is consulted and that the conclusions of the assessment are valid.

What Must Be Considered When Conducting An Assessment?

In performing the assessment, the employer must take into account:

- the methods and procedures used in the processing, use, handling or storage of the substance;
- the actual and the potential exposure of workers to the substance;
- the measures and procedures necessary to control such exposure by means of engineering controls, work practices, and hygiene practices and facilities.

Details on conducting an assessment are provided in Chapter 2 of this guide.

What Is the Control Program and Why Is It Necessary?

A control program consists of all measures that are taken to protect workers from exposure to the designated substance and of procedures to monitor exposure and worker health. Each program should be specially designed to suit the needs of the individual workplace. Hence, no two programs will be exactly alike, although they all must conform to several basic requirements.

When Is a Control Program Required?

A control program must be developed when the assessment has revealed that a worker is likely to inhale, ingest or absorb the substance and that his or her health may be affected by such exposure.

Who Is Responsible for the Control Program?

The employer is responsible for developing and implementing the control program and must do so in consultation with the committee. The committee may make recommendations to the employer regarding the measures and procedures to be incorporated into the control program and also regarding the way in which the program is carried out. Workers are required to comply with the provisions of the control program.

What Form Must a Control Program Take, and Who Receives a Copy?

The completed control program must be in the form of a written document. The employer must give a copy of the control program to each member of the committee, and must make it available at the workplace both in English and in the majority language of the workplace. The employer must also acquaint every worker affected by the program with its provisions.

What Must the Control Program Include?

The regulations require that every control program include provisions for:

1. Engineering controls, work practices, and hygiene practices and facilities to control worker exposure to the substance. For details on controls and work practices, see Chapter 4 of this guide and the guide for the appropriate substance.

2. Methods and procedures to monitor both the concentration of the substance in workplace air and the exposure of workers to the substance. The regulations require the results of monitoring to be given to the committee and posted in a conspicuous location at the workplace for at least 14 days, as soon as they are available. They must also be kept by the employer for at least five years. For a further description of

monitoring methods and procedures, see Chapter 6 of this guide.

3. Workers' records of exposure to the substance. These records are to be maintained by the employer and must include:

    - the worker's name, date of birth and occupation
    - respiratory equipment used by the worker, and
    - monitoring results that show the worker's exposure to the substance.

    A copy of these records must be given by the employer to the physician who examines the worker.

4. Medical examinations and clinical tests of workers, the records of which are kept by the examining physician. The medical examinations and clinical tests required by the control program are to be paid for by the employer and must meet the requirements set out in the particular regulation and in the Code for Medical Surveillance referenced by the regulation. For further details, see Chapter 7 of this guide.

What Happens if There Is a Dispute Between the Joint Committee and the Employer Over the Assessment or Control Program?

The regulations provide a mechanism for resolving disputes between the employer and the committee over the need for an assessment or control program or over the adequacy of the assessment or control program that has been developed. The employer, the committee or a member of the committee may notify a Ministry of Labour inspector when a dispute arises. The inspector then investigates the problem and gives a decision in writing. This decision can be appealed to a director, as provided for in the *Act*.

2. The Assessment

Each regulation requires an assessment to determine the extent to which workers are exposed to the designated substance. If such assessments are to be thorough and accurate, it is important that they be organized in a step-by-step manner, as outlined in this guide.

It may not be necessary to follow all of the steps suggested here—common sense is required to develop an assessment tailored to the specific workplace. However, those doing the assessment should become familiar with appropriate control methods and adverse health effects of the substance before starting the assessment, so they will be alert to any indications that a problem may exist.

The assessment should take into account the procedures used in handling the substance, the actual and potential exposure of workers to the substance and the procedures necessary to control such exposure. Although any data that have already been gathered on air quality, worker exposure and existing control measures may be useful, the core of the assessment should consist of information obtained from an inspection of the workplace to evaluate, at first-hand, the nature of worker exposure to the substance. This inspection may be supplemented by air sampling where necessary.

Consultation with occupational hygienists, engineers, designers, safety experts and occupational physicians or nurses may be needed when planning the assessment or evaluating the data. If required, advice is available from Ontario's safe workplace associations, occupational health clinics and training centre (addresses are listed in the back of this guide), as well as private consultants with industrial hygiene expertise.

The regulations require the employer to consult with the joint health and safety committee when conducting the assessment. Clearly, it is advantageous for those responsible for the assessment to discuss procedures with the committee during the planning stage and to encourage committee participation at each step of the process.

Step One - Identify Materials

Identify all materials handled in the workplace that contain the designated substance. Become familiar with how the substance is used in the workplace. One way of finding out whether a designated substance may be in materials used in a workplace is to contact suppliers and obtain from them material safety data sheets (MSDS) or other information on products that might contain the substance.

Record the quantities of the substance used, the manner in which it is handled and the physical form (e.g., solid, liquid, dust, fume, vapour, etc.) in which it is present.

Step Two - Draw a Map

Draw a sketch or a map of the plant lay-out that includes all areas where the designated substance may be present. Note the location of sanitary, hygiene and eating facilities. An example of such a sketch is shown in Figure 1.

Step Three - The Process Flow

Develop a process flow sheet for each process that uses the designated substance. This would be a step-by-step list or diagram that shows what happens to materials containing the designated substance from the time they enter the plant to the time they leave. The flow sheet should indicate how the material is transformed at each step, the various pieces of equipment used, any by-products that may be produced and quantities of the material involved. Remember to include storage and transportation from one area to another. Number each step of the process and indicate with a

corresponding number on the plant lay-out map where each step is located. An example of a process flow sheet is shown in Figure 2.

Step Four - Gather Information on Processes and Controls

Before inspecting the workplace, obtain existing data on processes and control measures currently in use in the plant. Record the following information, if available:

1. Engineering controls
   - general flow of air through the plant;
   - types of ventilation systems used;
   - location of local exhaust ventilation hoods;
   - method of obtaining make-up air, and location of air inlets;
   - capacity and efficiency of ventilation systems;
   - measures taken to isolate or physically enclose the machine or process.
2. Work practices for the handling, use and storage of materials.
3. Hygiene practices and facilities available for workers to wash and change clothes.
4. Housekeeping procedures.
5. Use of personal protective equipment.
6. Contingency plans for spills or equipment breakdowns.
7. Medical surveillance programs.
8. Air monitoring programs; results of air quality tests.

Figure 1

Plant Lay-out
Paint Manufacture – Lead

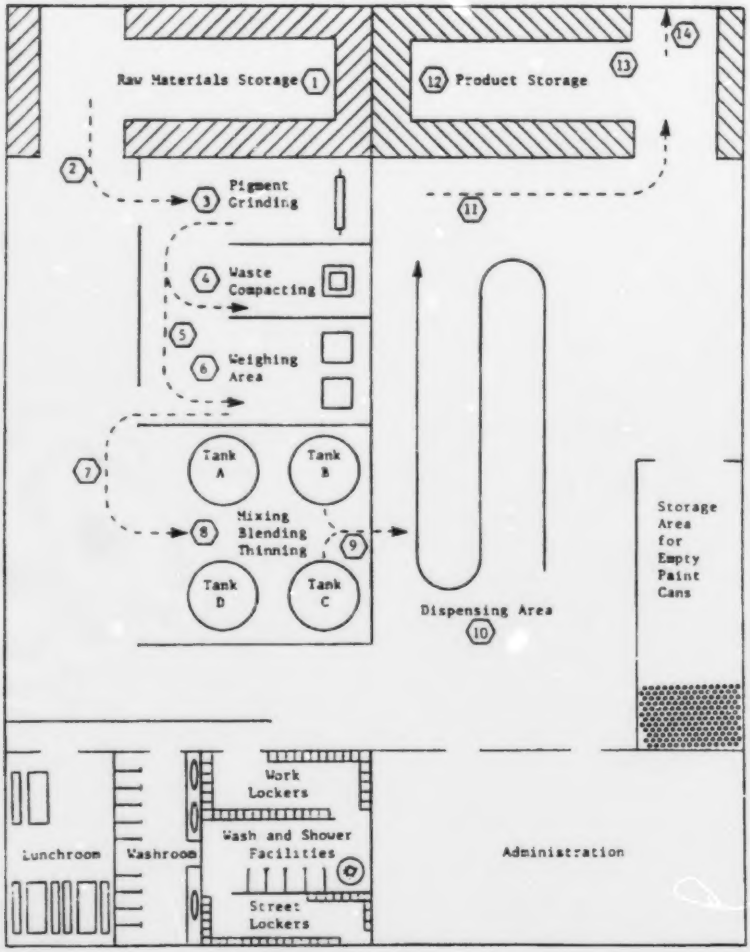


Figure 2

Process Flow Sheet
Paint Manufacture – Lead

PROCESS DESCRIPTION

(1) Raw materials on skids are moved by fork truck. 300 skids with 40 bags each are received per week. Each bag weighs 22 kilograms. Lead content of pigment varies from 0-35%. Some bags break causing spillage.

(2) Transfer of coarse, raw materials to grinding area is carried out using a fork truck.

(3) 20 bags of pigment are dumped by hand into the grinder. Dust generated is collected by an exhaust hood venting to atmosphere. Coarse pigment powder is ground into very fine powder during grinding (2 to 4 hours per batch).

(4) Empty bags are carried by hand ten metres to the waste compactor where they are compacted under an exhaust hood, wrapped with plastic and disposed in an approved landfill by a certified waste hauler.

(5) Pigment powder is dumped into small bins and transported by fork truck to weighing area. Bins do not have lids.

(6) All materials are carefully weighed. Dust generated is exhausted.

(7) Bins carrying approximately 500 kilograms of powdered materials are moved by fork truck to the mixing room. Bins do not have lids.

(8) Bin contents are dumped into large mixing tanks by opening a valve at the bottom of the cone-shaped bin. Ten bins are needed for one batch. Dust generated by dumping is exhausted. Solvents are added to the mixing tank via a closed system from outdoor storage tanks. Mechanical agitation is used.

(9) Paint is transferred via a closed system of pipes to the dispensing area.

(10) Dispensing into 4.5 litre cans is done on an automated assembly line.

(11) The sealed cans of paint are labelled and placed two in a carton on skids which are moved by fork truck to the storage area.

(12) Skids are stored at floor level until shipped.

(13) Trucks are loaded with skids of the product using the fork truck.

(14) Shipping occurs by truck transport.

9. Training programs to acquaint supervisors and workers with the hazards of the substance, precautions required for its handling, storage and disposal, personal hygiene practices and use of protective equipment.

10. Administrative controls to reduce the duration of worker exposure, such as work-rest schedules, job rotation or timing of hazardous procedures during periods when few workers are present.

Step Five – Inspection of the Workplace

Using the map as a guide, carry out an inspection of the workplace, observing every step in each process to determine the potential for exposure of workers to the substance. Following the numbered steps on the map and flow sheet will help to ensure that all operations involving the substance are noted. It should also increase awareness of potential hazards involved in the storage and transportation of the material.

The timing of the inspection is important. To get an accurate picture of the extent of worker exposure, it should be carried out at a time that is most representative of the work process. Intermittent or infrequent operations, such as batch processing, receiving raw materials, clean-up techniques and maintenance, should be noted. If night-shift procedures are different from those followed during the day, the assessment should take it into account. Also, seasonal differences in exposure conditions should be considered. For instance, there may be better general ventilation in the summer if windows and doors are kept open.

All information collected during the inspection tour should be recorded.

Both worker and management members of the joint committee should participate in the inspection. As the inspection proceeds, the following items should be noted:

1. **Sources of Contamination**

   a) How is the substance stored?

      - Where are storage areas located in relation to the rest of the plant?
      - What kind of containers are used for storage?
      - What is the possibility of leakage or spills from these containers?

   b) What kind of equipment is used in processing or transporting the substance?

      - Is it open or enclosed?
      - How often is it used?

   c) What is the possibility of this equipment releasing the substance into the workplace air?

      - During normal use?
      - During an emergency or as the result of an accident?
      - During maintenance?

   d) What components of the equipment might leak some of the substance into the workplace (valves, pumps, tank vents or other sources of leaks or emissions)?

   e) What maintenance precautions are taken to prevent this from occurring?

   f) In what physical state is the substance used (liquid, gas or solid)?

   g) In what form might the substance be released into the workplace (e.g., vapour, dust, fume, mist)?

   h) What evidence of contamination can be seen (e.g., dust on floor or equipment) or smelled?

If there is reason to think that the process may cause emissions of the substance into the workplace, air sampling may be necessary. For details, see Chapter 6.

2. **Possibility of Worker Exposure**

   a) How many workers are in each area/performing each job?

   b) What are workers doing at each step of the process?

   c) Where are they positioned in relation to sources of contamination and air inlets and outlets?

   d) Do they come in direct physical contact with the substance? If yes, what is the risk of inhalation, ingestion or skin absorption?

   e) Can dust or other evidence of contamination be seen on their work clothing, footwear, hair, face or hands?

   f) Are they using appropriate protective equipment? Is suitable equipment available for use in an emergency? Is the equipment cleaned and maintained as necessary?

   g) Is it possible that workers may be transporting the substance out of the work area on their hands, clothing, shoes or hair? If yes, are there hygiene facilities available so that they can wash themselves and change their clothes before leaving work?

   h) What facilities are used to launder contaminated clothing?

   i) Are signs posted warning that the substance is present? Are containers labelled with the name of the substance? Are material safety data sheets available?

   j) Do any workers enter the area on an intermittent basis? If yes, are they adequately protected from exposure to the substance?

   k) Are workers in an adjacent area likely to be exposed to the substance?

If worker exposure to the substance seems possible, medical tests may be advisable. For details, see Chapter 7.

3. Experience of Workers

a) Talk to workers in each area. Are they aware of any possible sources of contamination?

b) Are workers experiencing any symptoms of ill health that may be related to exposure to the substance? It is advisable to speak to the plant physician or nurse to determine whether any patterns in health ailments have been noted.

c) Is there a written job procedure? Are workers familiar with it?

d) Do workers display thorough knowledge of safety procedures and precautions? Are they aware of the toxicity of the designated substance and the health effects it may cause?

4. Engineering Controls

(For details on substance-specific control measures, see Chapter 4 of this guide and the guide for the appropriate substance.)

a) Are there provisions to control exposure by isolating, enclosing or automating processes wherever reasonable?

b) Is there local exhaust and/or general ventilation?

c) What is the source of make-up air? Where are air inlets located?

d) Where are local exhaust hoods located? Are they being used properly?

e) What are the provisions for periodic maintenance and checking of control measures?

f) Smoke tubes can be used to test the direction of air flow and the effectiveness of local exhaust hoods.

5. **Housekeeping Measures**

   a) If the substance accumulates in the workplace in the form of a dust, is it cleaned up by means of wet mopping, vacuuming or other methods that avoid dispersing dust?

   b) How is dust or contaminated refuse disposed of?

   c) Are floors and walkways kept obstacle-free to reduce the possibility of spills and accidents?

   d) How are spills cleaned up?

   e) Are eating areas and sanitary facilities kept clean and free of contamination?

6. **Emergencies and Malfunctions**

   a) What situations might lead to an accident, spill or leak? For example, could breakdown of equipment or operator error result in the release of hazardous concentrations of the substance?

   b) What equipment and facilities are available to handle an emergency?

      - Respiratory equipment?
      - Protective clothing?
      - Emergency clean-up equipment?
      - Showers, eyewashes?
      - First aid facilities?

   c) Are workers and supervisors trained to deal with emergency situations?

      - Is there a written emergency procedure?
      - Are there emergency drills? How frequent are they?

   d) Could unintended chemical reactions release hazardous concentrations of the substance?

Step Six – Air Sampling and Medical Examinations

Following the inspection, arrangements for air sampling and/or medical tests should be made if there is reason to believe that the airborne concentration of the substance is substantial (i.e., near to or greater than the exposure limits set out in the regulation) and/or that the health of workers may be affected by exposure to the substance. See Chapters 6 and 7 for details.

Step Seven – Organize the Information

All information gathered through the review of existing data, inspection tour of the workplace, sampling and testing should be organized and compiled. This information should be distributed to all members of the committee in preparation for analysis and evaluation, which is the next step in the assessment process.

Step Eight – Review and Analysis

The information collected in Step Seven should be analysed to determine the actual and potential exposure of workers to the substance, the adequacy of existing control measures and any further measures necessary to control exposure. This analysis should include an evaluation of:

1. potential sources of worker exposure to the substance;
2. present hygiene practices and facilities;
3. ventilation;
4. other engineering controls;
5. protective equipment procedures;
6. work practices, including provisions for emergencies;
7. training programs;
8. administrative controls;
9. medical surveillance programs;
10. air monitoring programs.

This evaluation should be done in co-operation with the joint committee. Consultation with occupational health experts may be useful in making this evaluation.

Step Nine - Writing the Assessment

A written assessment report that includes a summary of the information gathered and the analysis of these data should be prepared. The report must state whether there is actual or potential exposure of workers to the substance and whether their health may be affected. The conclusion of the assessment must indicate whether or not a control program is necessary. There are four possible conclusions:

1. Although the substance is present in the workplace, a control program is not necessary because it is not possible that the health of workers could be affected by exposure to the substance.

2. Although workers are exposed to the substance and there are some engineering controls to limit this exposure, there is no need for a control program because the health of workers is not likely to be significantly affected even if the engineering controls fail.

3. Existing control measures provide adequate worker protection; but should these controls fail or not be maintained properly, the health of workers may be affected. If this conclusion is reached, then a control program must be developed that incorporates existing control measures and other mandatory provisions as required by the regulation.

4. Workers are exposed to the substance in a manner that can affect their health, and further control measures are needed to provide sufficient protection. If this conclusion is reached, then a control program must be developed that establishes further control measures to protect the health of workers.

Conclusion of the Assessment

A draft of the assessment should be discussed by the joint health and safety committee. When agreement is reached on the assessment, a final report should be prepared. The assessment should be used to decide whether a worker's health may be affected by inhalation, ingestion or skin absorption and whether a control program will be needed. This assessment may also be helpful in the design of the control program, and should be available at the workplace for review by a Ministry of Labour inspector.

3. Developing the Control Program

If the assessment reveals that the health of workers may be affected by exposure to the designated substance, the employer must put into effect and maintain measures and procedures to control the exposure of workers to the substance. These measures and procedures must be incorporated into a written control program that must include provisions for:

- engineering controls, work practices, and hygiene practices and facilities to control the exposure of workers to the substance;
- methods and procedures to monitor the concentration of the substance in workplace air;
- personal records showing the exposure of workers to the substance;
- a medical surveillance program;
- records of medical examinations and clinical tests of workers.

The employer is required to consult with the joint health and safety committee when developing the control program. Close co-operation with the committee can ensure that personnel at all levels will understand the program and share a commitment to carrying it out. Staff can also contribute their ideas on the sources of contamination and possible control measures. It is important that senior management become involved in the development of the control program and demonstrate a firm commitment to its implementation.

The control program should outline general practices as well as very specific measures to control exposure at each step in the production process. The assessment document will be of great value in developing these measures. A systematic review of each exposure problem noted in the assessment can be the basis for determining the most effective controls to apply in each situation.

The control program should identify the workers who are to be included in each of its provisions (e.g., the job categories that are to be included in air monitoring and medical surveillance programs; the workers who are required to comply with specified work practices or hygiene practices). While medical surveillance and air monitoring may be required for all workers who are subject to the control program, the frequency of monitoring and medical examinations or tests could vary depending upon the extent of worker exposure to the substance.

The control program should also include a timetable for implementation. Provisions for interim control measures may be necessary in some cases. For example, the program may specify personal protective equipment that is to be used until engineering controls are installed.

The following chapters describe general principles of occupational hygiene that should be considered when establishing control measures. They also review requirements and recommended practices with respect to personal protective equipment, air monitoring, record keeping and medical surveillance.

4. Controlling Exposures

The designated substance regulations require that the control program include provisions for three general categories of controls: engineering controls, work practices, and hygiene practices and facilities. **Engineering controls** are methods of designing or modifying plants, equipment, ventilation systems, and processes to minimize the amount of substance in the workplace air. **Work practices and hygiene practices** are on-the-job activities that reduce the potential for exposure to a toxic substance. Some employers use **administrative controls** to limit the amount of time in which individual workers are exposed to the substance. These controls include job rotation schedules, work-rest cycles and timing of maintenance procedures. Another type of control is **personal protective equipment,** which is discussed in Chapter 5.

Engineering Controls Are the Best Defence

The best methods for controlling exposure to toxic substances are engineering controls incorporated into the design of the plant, equipment and processes. There are five basic types of engineering controls:

- substitution;
- process control;
- enclosure and/or isolation of emission source;
- local exhaust ventilation;
- general ventilation.

Substitution

Substituting less hazardous materials, equipment or processes can often be the least expensive and most effective control method. In some situations it may be possible to replace a designated substance with a less toxic material. For example, lead-containing paints may be replaced by paints containing other pigments; sandstone grinding wheels which generate silica dust may be replaced by `luminium oxide wheels. If the designated substance is completely removed from the workplace, the regulation would obviously no longer apply and the assessment and control program would not be required. In other cases, a less hazardous form of the substance can be used. For example, using the material in the form of a paste rather than powder will prevent dust dispersal.

Process Control

It may be possible to change the process in a way that reduces emissions. Using wet methods, rather than dry, in grinding or drilling operations will help control dust levels, for example. Dipping or painting with a brush instead of spray painting will considerably reduce the quantities of paint components that are released into the air. Improving instrumentation for mixing, metering and dispensing operations can be an effective way to prevent spills, reduce exposure to airborne contaminants and prevent direct skin contact with a substance.

Suitable process controls can include:

- lowering process temperatures so that less vapour is given off;
- transportation of materials via mechanical rather than manual methods;
- the use of alarm signals that can warn of ventilation or equipment failure;
- over-pressure cut-off switches;
- automation.

Enclosure and Isolation

Enclosing a process or equipment can be very effective in reducing the amount of a substance released into the workplace. Keeping the enclosed process or equipment under negative pressure by means of exhaust ventilation and the use of double mechanical seals on pumps and valves affords still greater protection. When enclosed equipment is opened, for cleaning or filling, special precautions should be taken to prevent release of the substance. Diligent maintenance of pumps, valves and gaskets is important in preventing contaminants from escaping. Designated substances should be stored and transported in tightly sealed containers.

Isolation can separate workers from processes using a designated substance. Storage facilities or hazardous processes may be located in areas of the plant that are physically or geographically separate from where many workers are present. If high risk manual operations are unavoidable, glove boxes, remote control devices or robots may be used to minimize worker exposure. An alternative is to situate work stations in contaminant-free enclosures or booths, especially where automated processes are used.

Local Exhaust Ventilation

Local exhaust ventilation is one of the most effective means of controlling workplace contamination and should be used when other methods are not adequate to prevent exposure. A local exhaust ventilation system has four main parts:

- **the hood,** where contaminated air enters the ventilation system;
- **ducts,** which carry contaminated air away from its source;
- **the air-cleaning device**, which removes contaminants from air before it is discharged;
- **the fan and motor,** which draw air into the system and discharge it after cleaning.

The design of each of these parts must be suited to the particular process and contaminant in question. For this reason, the ventilation system should be designed by a specialist. When developing a control program, it is important to establish provisions for the design of an effective and appropriate local exhaust ventilation system and for proper maintenance of the system once it is installed. Even the best-designed system will fail to function well if it is not properly maintained. If fans, air cleaning devices and ducts are not cleaned regularly, they may become clogged with dust, which will prevent them from operating effectively. When changes in processes or additions to the original ventilation system are made, it is essential to evaluate the impact of these changes on the effectiveness of the ventilation system as a whole.

In developing the provisions in the control program that deal with local ventilation, the following principles should be borne in mind:

1. Hoods should be as close to the source of contamination as possible. The best type of hood completely surrounds the source of emissions so that there is no opportunity for the substance to enter workroom air. The shape of the hood should be designed to maximize the exhaust of contaminated air.

2. The rate at which air is drawn into the hood must be sufficient to capture as much of the contaminant as possible. The ideal "capture velocity" (the rate of air movement toward the hood at the source of contamination) will vary according to the type of process that generates the contaminating substance, the degree of air movement in the workplace and the distance from the hood. Cross-drafts in the workplace can significantly affect the capacity of a local exhaust system to remove airborne contaminants.

3. Exhaust hoods should be located so that they do not interfere with the performance of work and so that contaminated air is not drawn into the breathing zone of the worker.

4. The velocity with which air is conveyed through the system should be high enough to prevent excessive settling of contaminants within the ductwork. Good duct design can also help prevent excessive settling of dust.

5. The fan should be located "downstream" of the air cleaning device so that it is less likely to be damaged by contaminants in the exhausted air.

6. Air vented to the outside environment must be cleaned in accordance with the standards of the Ministry of the Environment.

7. An adequate and clean supply of make-up air is essential to the proper functioning of an exhaust system. Make-up air must be heated where required. The intake vent should be located so that contaminated exhaust air is not drawn into the workplace.

Detailed information on local exhaust ventilation is available in the references listed at the back of this guide.

General Ventilation

The principle of general, or dilution, ventilation is the use of large volumes of air to dilute the concentration of airborne contaminants. When the workplace contains hazardous contaminants, such as a designated substances, general ventilation usually does not, by itself, offer adequate control. It can, however, be used to prevent accumulation of contaminants that are not removed by other control methods. It is important that a general ventilation system include an adequate supply of make-up air to replace air removed by exhaust. If this is not provided, a negative pressure can be created within the workplace, and this can adversely affect the operation of equipment and exhaust fans. The direction of air movement should be from clean, non-contaminating operations to dirty or contaminating operations.

Work Practices Can Ensure Safe Working Conditions

Well-designed and maintained engineering controls must be supplemented by diligent adherence to good work practices if workers are to be protected from exposure to a designated substance. These work practices should be spelled out in the control program and may include the following:

- standard work procedures;
- housekeeping;
- equipment maintenance;
- safety practices and emergency provisions.

A standard work procedure is important to ensure that each operation is performed in the safest possible manner. It is strongly recommended that this procedure be written down; this can help to simplify the training of new workers, promote understanding of safe practices among all parties in the workplace and prevent the omission of important health considerations.

Good housekeeping procedures are especially important when a designated substance is released in a particulate form. Proper design of the workplace can help to ensure that good hygienic conditions are maintained. For example, the presence of ledges, beams and other surfaces on which dust can accumulate should be kept to a minimum. Cleaning techniques should not contribute to the dispersal of dust through the workroom atmosphere. To avoid such dispersal, cleaning should be performed using wet sweeping, sweeping-compounds or vacuum cleaners equipped with special filters or other devices to prevent dust from being re-circulated into the air. Care must be taken to avoid occupational or environmental pollution when disposing of contaminated refuse.

Regular maintenance of equipment can help prevent leaks or emissions of a designated substance into the workplace. Equipment used for control practices, such as ventilation systems or vacuum cleaners, must also be well-maintained. Special precautions may be necessary when cleaning or maintaining

equipment contaminated by a designated substance. For example, maintenance workers may require protective clothing and equipment, and it may be necessary for other workers to move from the area during maintenance operations.

Safety practices and emergency provisions are required to guard against designated substance exposures that could result from accidental spills and leaks. The control program should specify measures designed to prevent such accidents. These may include:

- storing materials in appropriate containers away from work areas, and proper ventilation of storage areas;
- posting warning signs and labelling hazardous materials;
- preventive maintenance and prompt repair of damaged equipment;
- keeping aisles, corridors or walk-ways well-lit and obstacle-free;
- minimizing the need to transport or transfer materials through the plant;
- using mechanical rather than manual means of moving materials wherever possible.

The control program should also specify clean-up procedures to be used in the case of emergency. Spills and leaks have to be cleaned up promptly to minimize the risk to workers. Where appropriate, protective equipment, first-aid facilities, deluge showers and eye washes should be readily accessible locations for emergency use.

Hygiene Practices and Facilities

Personal hygiene practices can reduce the amount of a designated substance absorbed by a worker. They are especially important when the contaminant is released in a form that can accumulate on workers' hands, clothing and hair. If such contamination is not completely removed after a work shift, workers run the risk of exposing both themselves and their families to the substance. Where this is a possibility, the control program should provide for **hygiene**

facilities in which workers can shower and change into clean clothes.

Important principles to remember when planning for effective hygiene practices and facilities include the following:

1. Workers should wash hands before eating, drinking or smoking. They should be given enough time before meals and breaks for adequate personal hygiene.

2. Smoking, drinking, chewing and eating should not be allowed in work areas. Food and cigarettes should be stored in non-contaminated areas.

3. Hygiene facilities, where appropriate, should be designed to prevent contamination of clean clothes by dirty clothes. Well-designed hygiene facilities customarily feature showering and washing areas located between "clean" and "dirty" changing areas. Before beginning a shift, workers remove their street clothes in the "clean" areas and store them in lockers or other receptacles. They then enter the "dirty" areas, where they put on their work clothes. After the shift, work clothes are removed in the "dirty" areas and either stored or decontaminated. After removing work clothes, workers wash and shower before entering the "clean" area, where they put on their street clothes. A sample floor plan for a double locker facility is illustrated in Figure 3 on page 37.

4. Fixtures and surfaces in the hygiene facilities should be made of smooth, impervious materials that will not trap and accumulate a designated substance. The facilities should be regularly cleaned and maintained.

5. The facilities should be suitably heated and large enough to accommodate the number of workers using them. They should be supplied with sufficient hot and cold running water, soap, nail brushes and towels.

6. Lunch-rooms, rest areas, drinking fountains and vending machines should be located where there is no risk of contamination.

7. Workers should remove outer protective clothing and clean their hands, arms, face and nails before entering rest areas or lunch-rooms.

8. Worker education programs should stress the importance of good hygiene practices, such as washing hands before eating and smoking, avoiding touching lips, nose and eyes with contaminated hands, and thorough cleaning at the conclusion of a shift.

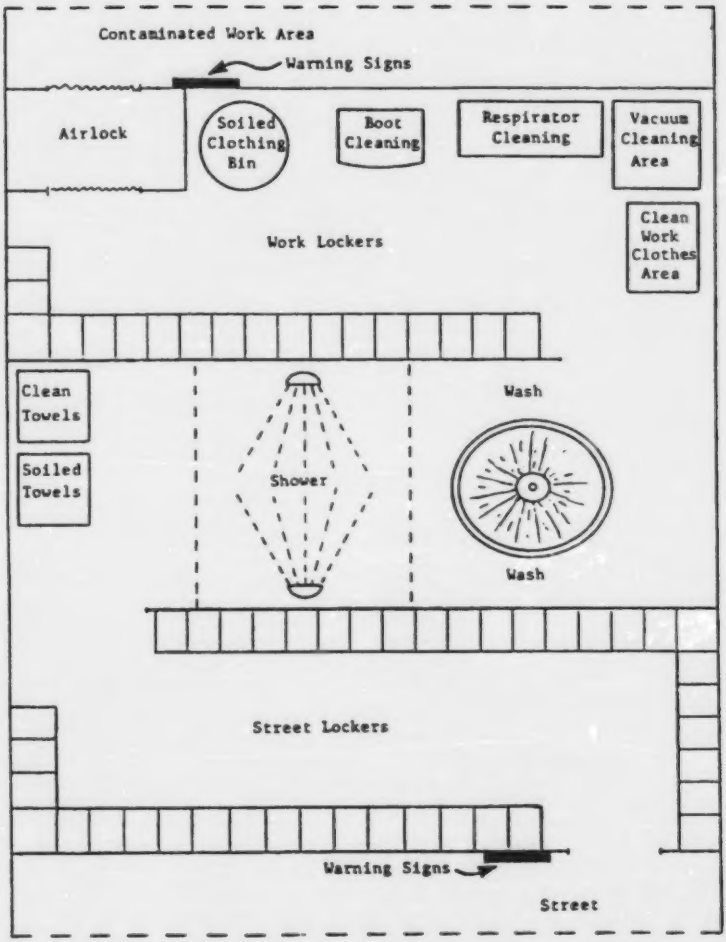
Administrative Controls Reduce Individual Exposures

Administrative controls comprise personnel practices that can reduce a worker's exposure to a contaminated environment. They may include:

- scheduling maintenance, or other high exposure operations, at times when few workers are present;
- job-rotation schedules that limit the amount of time each individual worker is exposed to a designated substance;
- work-rest schedules that limit the duration of worker exposure to a designated substance.

Figure 3

Dual Locker Lay-out



5. Personal Protective Equipment

Personal protective equipment includes respirators, protective clothing, footwear and face and eye shields, which can reduce or prevent the absorption of a designated substance present in the environment. While it is important to include provisions for personal protective equipment in the control program, such equipment should never be used as a substitute for measures that control the emissions of the substance into the workplace.

Protective Clothing

The type of protective clothing selected must be appropriate to the substance and the process being used. It should be designed to provide the worker with maximum comfort and freedom of movement. Protective clothing protects against the harmful effects of a designated substance in two ways:

1. It can be a direct barrier between the substance and the skin. This is important when the substance can either damage the skin directly or be absorbed into the body through the skin. Where the prevention of direct skin contact is a concern, protective clothing should be made of impermeable material and include gloves and footwear. Such clothing is often hot and uncomfortable to wear; precautions should therefore be taken to avoid heat stress.

2. Protective clothing can prevent contamination of a worker's street clothing or hair. This can reduce the chance of the substance being absorbed after the worker has left the work environment. It also prevents the worker from transporting

the substance to non-contaminated areas, where it may pose a risk to other workers or members of the community. Such clothing should be made of fabrics designed to minimize dust retention, and should include coverings for both the head and feet. Openings at the cuffs and neck should be tight-fitting, to prevent penetration by the substance. This is especially important where street clothes are worn beneath protective clothing.

The control program should specify cleaning procedures to decontaminate used clothing. Workers handling the contaminated clothing must also be protected from exposure to the designated substance. The clothing should be cleaned by a laundry designed to handle the material; under no circumstances should it be taken home by the worker where it may expose family members to the substance. Protective clothing should be inspected regularly for damage.

Respiratory Protection

A respirator allows the user to breathe uncontaminated air by one of two methods:

- by acting as an air purifier and removing contaminants on a filter or in a chemical cartridge as the air is breathed in; or
- by supplying clean air to the user from an external source.

The type of respirator required depends on the designated substance and the concentration at which a worker is likely to be exposed. Each designated substance regulation references a Code for Respiratory Equipment, which specifies the type of respirator required. However, the requirements of the Codes assume that the respirator is required to protect against only one designated substance. **If protection against more than one contaminant is necessary, the selection of a respirator must take this into account.**

Air Purifying Respirators

Mechanical filter respirators protect the user from exposure to particulate matter such as dusts, mists, fume and smoke. **Chemical cartridge respirators** are used against vapours and gases. If both particulate and gaseous contaminants are present, a combination mechanical filter/chemical cartridge respirator should be used. Air purifying respirators are available in quarter-mask, half-mask and full face-piece styles. Full face-piece styles are generally required when there is a danger of eye irritation or direct skin contact.

Powered air purifying positive pressure respirators use a battery-powered or stationary pump to force air through the filter, creating a positive pressure within the face-piece so that any leakage is outward.

Atmosphere Supplying Respirators

Supplied air respirators provide air to the breathing zone through an airline connected to a compressed air cylinder or compressor that picks up outside air. Air may be supplied in one of three ways:

- continuous flow: a positive pressure is maintained within the face-piece;
- demand: air is supplied only when the user inhales;
- pressure-demand: a positive pressure is maintained within the face-piece and air is supplied on inhalation.

Self-contained breathing apparatus (SCBA) is equipped with a source of clean air or oxygen that is carried by the user. It is used in emergency situations, when the use of supplied-air respirators is not practical and where the concentration of contaminants is so high that rapid escape may be necessary. SCBAs should be operated in the same way as a pressure-demand respirator.

A Detailed Program for Respirator Use Is Essential

In most situations employers must comply with exposure limits by means of engineering controls, work practices, and hygiene practices and facilities without resorting to respirators. In the following exceptional circumstances, however, respirators may be used to reduce exposures below the exposure limit:

- in an emergency where workers are exposed to immediate danger, such as during a process upset, a spill or equipment breakdown;
- where control measures do not exist or are unavailable;
- where control measures are not reasonable or practical for the length of time or frequency of exposures or the nature of the process, operation or work;
- where control measures are not effective because of a temporary breakdown.

If the exposure level exceeds the time-weighted average exposure limit or the maximum concentration limit in such circumstances, the employer must provide the worker with an appropriate respirator and the worker must wear it.

Some of the designated substance regulations (e.g., acrylonitrile, benzene and silica) require that wherever a worker is exposed to the designated substance, the employer must provide a respirator to the worker if one is requested.

The use of respirators must meet the requirements laid out in the Code for Respiratory Equipment referenced in each regulation.

A program of respiratory protection is effective only if scrupulous attention is given to all aspects of respirator selection, maintenance, testing and fitting. To help ensure this, one individual should be assigned responsibility for the respirator program. It is essential that written standard operating procedures be developed, as required by the Code. Guidance for developing these procedures

can be found in the Canadian Standards Association (CSA) Standard Z94.4-93, "Selection, Use and Care of Respirators".

The written operating procedures should incorporate the following principles of good respirator use:

1. The type of respirator used must satisfy the requirements of the Code. Although it is not mandatory, it is recommended that the respirators be certified by the U.S. National Institute for Occupational Safety and Health (NIOSH) or The British Standards Institution (BSI).

2. Respirators (except continuous flow or pressure-demand supplied air respirators) must be properly fitted so that there is a good seal between the face-piece and the skin. Because facial hair can interfere with a proper seal, users should be clean-shaven. Respirators should be available in a variety of sizes and shapes to accommodate differences among workers.

3. There must be a regular program for the cleaning and maintenance of respirators by specially trained individuals. When one respirator is used by more than one worker, it must be disinfected after each use.

4. Where practical, respirators should be assigned to workers on a personal basis and marked with the user's name. This can help to assure proper fit and hygiene.

5. There must be a regular program for testing and inspecting respirators. Some fairly simple tests can be performed by workers themselves before each use, and instruction in testing techniques should be included in training programs. Details on test techniques are available from the manufacturer or can be found in the references cited at the back of this guide.

6. Respirators are often hot and uncomfortable to wear. They usually restrict verbal communication, and some users may experience breathing difficulty when wearing one. These are some of the reasons why the prolonged use of respirators should be avoided wherever possible. When this is not possible, it is advisable to structure work-rest cycles or job rotation schedules so as to limit the problems associated with respirator use. It is also important for worker-comfort to be one of the major factors taken into account when selecting the type of respirator to be used.

7. The types of mechanical filters and chemical cartridges used must be appropriate to the form and concentration of the designated substance. Filters, cartridges and disposable respirators must be disposed of when they have reached their filtering capacity.

8. The quality of compressed breathing air, compressed oxygen, liquid air and liquid oxygen used with supplied air respirators must meet the requirements of CSA Standards.

9. Respirators must be carefully stored where they will not become contaminated by dust present in the workplace air. It is preferable to store them under negative pressure.

10. Workers must receive thorough training in the proper use of respirators. Those responsible for the maintenance, repair, testing and fitting of respirators should also receive comprehensive training.

11. Regular air monitoring should be conducted in areas where respirators are required, to ensure that the type of respirator used is appropriate for the concentration of the substance.

6. Air Monitoring and Exposure Records

Air monitoring refers to a procedure for determining the concentration of a contaminant in workplace air. It usually involves collecting representative samples of the substance from the air and having them analysed to determine the quantity of the substance present.

There are a number of reasons why employers covered by a designated substance regulation may need to perform air monitoring:

- to determine the extent of exposure to the substance as part of the assessment;
- to demonstrate compliance with the exposure limits prescribed by the regulation;
- to obtain information that will aid in the choice of appropriate control measures and/or respirators;
- to evaluate the effectiveness and performance of existing controls;
- to record the personal exposure of workers to the substance.

Some designated substance regulations reference a Measurement Code that specifies the methods and procedures that are to be used for the air sampling and analysis necessary to demonstrate compliance with the exposure limits prescribed by the regulation and to meet the requirements of the control program if one is required. Unless an employer uses methods and procedures that can be demonstrated to be equal to or better than those in the Code, with respect to the factors of accuracy and precision, the standard practices in the Measurement Code must be followed.

Other regulations simply require the air monitoring to be "in accordance with standard methods for workplace air sampling and analysis". Methods published by agencies such as NIOSH (the U.S. National Institute for Occupational Safety and Health), OSHA (U.S. Occupational Safety and Health Administration), HSE (U.K. Health and Safety Executive), ASTM (American Society for Testing and Materials) and ISO (International Organization for Standardization) would meet this requirement.

The collection of air samples generally requires an air sampling train consisting of three components:

- a collection device, such as a filter holder, tube or impinger, containing a medium that can remove the substance being measured from the air stream;
- a flow meter, which indicates the rate of air flow through the air sampling train; and
- a portable air-sampling pump.

Air samples are obtained by drawing air through the collection device at a known rate for a known period of time. The quantity of the substance collected is then determined through laboratory analysis. Using the laboratory analysis with the known volume of air drawn through the collection device, it is possible to calculate the concentration of the substance in the sampled air.

The regulations require that the control program include provisions for air monitoring and for maintenance of records showing the personal exposure of workers to the substance. The program should outline a "sampling strategy" that specifies where air sampling trains will be placed, the duration of sampling and the total number of samples to be taken in each survey. It should also indicate how frequently monitoring will be performed. Important factors to be considered when developing an air monitoring program are discussed below.

Personal or Area Sampling

Depending on the kind of information desired, monitoring may be performed by using either personal or area sampling.

Personal samples are obtained by sampling air as close as possible to the breathing zone of the worker. Wherever possible personal sampling should be used for determining the exposure of a worker to the substance.

Area sampling is performed by placing the sampling train at a strategically selected location in the workplace. Area sampling may be chosen for the following reasons:

- as a preliminary step to personal sampling to determine which workers may be at greatest risk;
- to investigate the effectiveness of control measures or to plan for needed controls;
- to determine the general concentration of a substance in a work area in order to assess what type of respirators or other protective mechanisms are required.

If the movement of workers in and out of sampled areas is carefully documented, it is possible to calculate personal exposure levels from the results of area sampling. This may be necessary when personal sampling methods are not available. This is not, however, a recommended method for determining personal exposure levels if suitable personal sampling methods are available.

Duration of Sampling

Duration of sampling (i.e., the length of time during which air is drawn through the sampling device) depends on the type of collection medium, exposure concentration being measured, (e.g., time-weighted average or maximum concentration), the anticipated airborne concentration and the sensitivity of the analytical method. When determining the eight-hour time-weighted average exposure concentration, sampling is usually conducted for six to eight hours,

or for a full workshift, either as one sample or several shorter samples in sequence. Sampling for more than one workshift during a week may be necessary to assess interday variations in air concentrations and to determine the 40-hour time-weighted average. Conversely, a shorter sampling duration may be used if the results reflect representative exposure levels. For example, if exposure conditions are uniform throughout the entire workshift, a two-hour sample might provide an accurate indication of exposure for that shift.

When determining compliance with the maximum concentration, i.e., for regulations, such as lead or mercury, which specify a 15-minute short-term exposure, a series of 15-minute samples should be taken during time periods when maximum emissions are expected. If the regulation does not specify the time period, then guidance on the sampling duration is given in its Measurement Code.

When to Conduct Sampling

In most workplaces fluctuations occur in the concentrations of air contaminants. Before establishing a sampling strategy, it is therefore important to thoroughly evaluate the operations in order to determine when, and under what conditions, the substance may be released. Representative sampling times should then be chosen so that it will be possible to calculate exposure over a full work week. For example, if operations vary slightly from day to day, it may be sufficient to base calculations of the 40-hour time-weighted average exposure on full-shift sampling conducted for one day. If there is considerable daily variation, then sampling should be done on different days representative of the different exposure conditions. If exposure conditions vary from week to week, sampling should be performed during a week when levels are expected to be highest. It is recommended that an occupational health professional, such as an occupational hygienist, be consulted to determine an appropriate sampling program. The professional should consult with the joint health and safety committee, with workers and others with first hand knowledge of working conditions on the plant floor.

How to Calculate the Time-Weighted Average Exposure

The time-weighted average exposure of workers to a designated substance must be calculated according to the Schedule in its regulation. The results of these calculations may be certified by a Ministry of Labour inspector. This means that a ministry inspector may review the records to ensure that the appropriate data were used and that the results are representative of a worker's exposure.

In order to calculate the time-weighted average exposure accurately, it is essential that the sampling records indicate the nature of exposure conditions during the sampling period. These would include, for example, the operation or process being conducted during sampling, ventilation conditions and (for personal sampling) movement in and out of the work area during the sampling period.

To ensure that the sampling results used to calculate the time-weighted average exposure of a worker are truly representative, the following questions should be answered:

- What was the schedule and pace of the work?
- Was the production rate similar for the entire work day and work week?
- What was the natural ventilation condition during the entire day and week (e.g., opening or closing of doors and windows)?
- Was there mechanical ventilation? What type?
- Was the mechanical ventilation on, off or intermittent during the day and the week?
- Was respiratory/protective equipment provided and used? What type? Was the same type of equipment used all week? Was the equipment properly fitted? Was it properly worn? Was it maintained and in good condition?
- Was the duration of the operation at the time(s) of sampling typical for the entire day and week?

- Is the same material/substance used each day, and is the percentage of mixture or quantity similar?
- Were the same workers present during the entire 8-hour and 40-hour time periods?
- Were the samples taken under representative conditions for the work day and work week?
- Was the worker exposure calculated as set out in the Schedule?
- Was the calculation made on the basis of area or personal samples or a combination of both?

If the samples are representative of exposure conditions over the course of the day and the week, 8-hour and 40-hour time-weighted average exposure concentrations can be determined from the information. To do this, it is necessary to estimate, for each sample, the number of hours per day and per week that the worker was exposed to the concentration determined for the sample. Each concentration (C_n) is then multiplied by its corresponding exposure time in hours (T_n). To determine the cumulative daily and weekly exposure, all C_nT_n values in the representative exposure period (8 or 40 hours) are added together. This may be expressed as:

Cumulative Daily or Weekly Exposure = $C_1T_1 + C_2T_2 + \ldots C_nT_n$

C_1 = concentration in the first time period
C_2 = concentration in the second time period
T_1 = duration of the first time period (in hours)
T_2 = duration of the second time period (in hours)

Finally, in order to determine the time-weighted average exposure, the cumulative daily or weekly exposure must be divided by 8 or 40, as the case may be and regardless of the number of hours actually worked.

Example 1: Full Shift Sampling (five eight-hour days)

A worker is exposed to a solvent containing benzene. In order to determine the exposure to benzene, a series of five personal air samples were taken during the week. The results of the sampling and the number of hours the worker was estimated to be exposed can be listed as follows:

	Concentration	Total Time in Hours to Which the Worker is Taken to be Exposed to Concentration C_i in a Week
Day 1	0.7 ppm (C_1)	$8(T_1)$
Day 2	0.5 ppm (C_2)	$8(T_2)$
Day 3	1.5 ppm (C_3)	$8(T_3)$
Day 4	1.0 ppm (C_4)	$8(T_4)$
Day 5	0.2 ppm (C_5)	$8(T_5)$

$$TWA_8 = \frac{C_1 T_1 + 0}{8}$$

$$TWA_8 = \frac{5.6 + 0}{8} = 0.70 \text{ ppm}$$

$$TWA_{40} = \frac{C_1 T_1 + C_2 T_2 + C_3 T_3 + C_4 T_4 + C_5 T_5}{40}$$

$$= \frac{5.6 + 4 + 12 + 8 + 1.6}{40}$$

$$= 0.78 \text{ ppm}$$

Thus, the worker has an 8-hour time-weighted average exposure of 0.7 ppm and a 40-hour time-weighted average exposure of 0.78 ppm.

Example 2: Full shift sampling using two consecutive six-hour samples each day.

In this case the work-week consists of four 12-hour days rather than five eight-hour days.

	Concentration	Total Time in Hours to Which the Worker is Taken to be Exposed to Concentration C_1 in a Week
Day 1	0.6 ppm (C_1)	$6(T_1)$
	0.8 ppm (C_2)	$6(T_2)$
Day 2	0.4 ppm (C_3)	$6(T_3)$
	0.6 ppm (C_4)	$6(T_4)$
Day 3	1.4 ppm (C_5)	$6(T_5)$
	1.6 ppm (C_6)	$6(T_6)$
Day 4	0.1 ppm (C_7)	$6(T_7)$
	0.3 ppm (C_8)	$6(T_8)$

Note that even though the worker was exposed for 12 hours a day and 48 hours a week, the time-weighted average exposure is calculated for an 8-hour and a 40-hour exposure.

$$TWA_8 = \frac{C_1 T_1 + C_2 T_2}{8}$$

$$= \frac{3.6 + 4.8}{8} = 1.05 \text{ ppm}$$

$$TWA_{40} = \frac{C_1T_1 + C_2T_2 + C_3T_3 + C_4T_4 + C_5T_5 + C_6T_6 + C_7T_7 + C_8T_8}{40}$$

$$= \frac{3.6 + 4.8 + 2.4 + 3.6 + 8.4 + 9.6 + 0.6 + 1.8}{40}$$

$$= 0.87 \text{ ppm}$$

Thus, the worker has an 8-hour time-weighted average exposure of 1.05 ppm and a 40-hour time-weighted average exposure of 0.87 ppm.

Determining the Personal Exposure of Workers

Each regulation requires the employer to maintain records of the personal exposure of workers to the designated substance. To do this, it may not be necessary to monitor each worker individually, unless the number of workers in the workplace is very small. If every worker is not monitored, it is recommended that personal exposures be determined by assigning each worker to an appropriate exposure category within which similar conditions of exposure exist.

Choosing Exposure Categories

Exposure categories, in some cases, may be the same as job categories, but it is possible that workers who nominally perform the same job are exposed to different levels of the substance. In determining how to group workers into exposure categories, all factors that can affect extent of exposure must be considered. Criteria used to assign workers to exposure categories include:

- nature of the work performed;
- worker's location in relation to contamination sources;
- worker's movement in and out of contaminated areas.

To make record keeping easier, it is recommended that each exposure category be assigned a number.

How Many Workers to Monitor

When there are fewer than six workers in an exposure category, then all the workers in the category should be sampled. If the number of workers in the exposure category is six or more, monitoring should be performed on a sample of the workers.

The following chart, developed by the U.S. National Institute for Occupational Safety and Health (NIOSH), relates the number of workers to be monitored to the size of the exposure category. If the chart is followed, there should be 90 per cent confidence that at

least one worker in the highest 20 per cent of exposure levels has been monitored.

Size of Group*	6	7-9	10-14	15-26	27-50	51+
No. of workers to be sampled	5	6	7	8	9	11

* If the group is less than six workers, each worker is to be sampled.

(Adapted from *Occupational Exposure Sampling Strategy Manual*, U.S. Department of Health, Education and Welfare.)

In deciding which worker exposure categories to monitor, it is preferable to choose those workers who are estimated to be at greatest risk of exposure. These categories will usually be those in which the workers are closest to the source of emissions for the longest period of time.

The selection of workers for monitoring from within an exposure category should be done at random, if it is not possible to determine which workers are at greatest risk. (A random sample can be selected by drawing names out of a hat or by assigning a number to each worker and using a random number table.)

Results May Vary Widely

It is not unusual for workers in the same exposure category to have a wide range of exposure levels due to personal work habits, differences in work operations or random variation in exposure and sampling conditions. For example, it is possible for five per cent of workers in one category to have exposures two to three times higher than the average. For this reason, it would be erroneous to assign the average exposure level to all workers in the category. It is therefore recommended that records show the average exposure and the range (highest and lowest) of exposure values obtained.

If any of the exposure values deviate excessively from the average (by a greater margin than can be explained by random variation), one of three problems may exist:

1. The deviant value may be due to a defect in equipment or an error in sampling. If this is the problem, the sampling equipment should be repaired if necessary and sampling should be re-done. This explanation is relatively rare.

2. The deviant value may be due to improper assignment of a worker to the exposure category. The criteria used should be reviewed.

3. The deviant value may be due to an unusual or extreme exposure condition. Investigation of work habits and operations should follow immediately. Further air sampling may be required.

From the air monitoring results, time-weighted average exposure levels should be calculated for all workers sampled. Air monitoring records should indicate the following:

- results of air monitoring for all workers sampled;
- calculated time-weighted average exposure levels for all workers sampled;
- the range (lowest and highest) of time-weighted average exposure levels for each exposure category;
- the average (mean) time-weighted average exposure level and standard deviation for each exposure category;
- some indication of past exposures to show trends in exposure levels in recent times.

In addition, the following information should be recorded each time air monitoring is performed:

- date of sampling;
- number of workers sampled in exposure category;

- average (mean) time-weighted average concentration and standard deviation for the exposure category;
- range (highest and lowest) of time-weighted average exposure values for the exposure category;
- results of personal sampling for the individual worker if it has been performed;
- use and type of respiratory protective equipment.

Posting and Record Keeping

The designated substance regulations require the results of air monitoring to be given to the joint committee and posted in the workplace by the employer as soon as they are available. They must be placed in a conspicuous location accessible to the workers for a period of at least 14 days. Employers are required to keep air monitoring records for a minimum of 5 years. Copies of these records must also be furnished to the examining physician. The examining physician must keep the records in a secure place for 40 years from the time such records were first made or for 20 years from the time the last of such records were made, whichever is longer. If the physician is no longer able or willing to keep the records, the records must be forwarded to the Provincial Physician, Ministry of Labour. Personal exposure records should include the following information:

- worker's name;
- social insurance number;
- date of birth;
- jobs or occupations performed at the workplace;
- date hired;
- date of termination;
- exposure category.

Frequency of Air Monitoring

The frequency with which air monitoring is performed should be discussed and then specified in the control program and be based on the exposure conditions in the individual workplace. Employers

should seek the advice of an occupational health professional and consult with the joint health and safety committee and workers with first hand knowledge of working conditions on the plant floor.

If exposure levels regularly approach or even exceed the allowable limits, air monitoring should be performed at least on a monthly or quarterly basis. If there are any differences between summer and winter ventilation, air monitoring should be conducted during both seasons. Where exposure levels are usually much lower than prescribed limits, less frequent monitoring is permissible.

Monitoring should always be performed when there are any changes in the process or conditions of exposure. Monitoring should also be conducted during and after emergencies, spills or other unusual operating conditions where a high exposure situation is likely or may persist.

Air Sampling Personnel

Sampling must be conducted by personnel who are competent to conduct air quality surveys, i.e., who have the ability to calibrate, set up and operate air quality monitoring instruments and to accurately record essential information. The employer may hire staff trained in sampling techniques or train employees who are already on staff. Alternatively, the employer may hire outside consultants to conduct air quality surveys, but they must be competent to do the job.

7. The Medical Surveillance Program

The designated substance regulations require the control program to provide for medical surveillance that includes:

- pre-employment and pre-placement medical examinations;
- periodic medical examinations;
- clinical tests;
- health education;
- record keeping.

Medical surveillance serves as a backup to the engineering and work practice control methods required by the regulation. The objectives of the medical surveillance program are both preventive and remedial. By providing a regular check on the health of workers exposed to the substance, the employer and the committee can be alerted to exposure problems that might otherwise go unrecognized. Health education to acquaint workers with the health effects of the substance and means of curtailing exposure is another preventive function of the program. Medical surveillance also allows remedial steps to be taken if a worker's health is affected by exposure to the substance or if clinical tests reveal excessive absorption of the substance.

This section of the guide is intended to acquaint the reader with the obligations of the various parties with respect to the medical surveillance program. While it briefly reviews the responsibilities of the physician, it is not meant to serve as a guide for conducting medical examinations or clinical tests. These are described in greater detail in the Code for Medical Surveillance referenced by each regulation.

Who Is Responsible for the Medical Surveillance Program?

The regulations and the Codes for Medical Surveillance place a number of responsibilities on different participants in the health and safety system at the workplace. The employer is responsible for seeing that a medical surveillance program is established in accordance with the regulation and the Code and ensuring that the control program incorporates clinical tests as required by the Code. The employer must also bear the costs of required medical examinations and clinical tests. The joint committee receives from the examining physician, on a confidential basis, advice and the results of clinical tests and uses this information in evaluating and improving controls to reduce work exposures. Workers may participate by undergoing the medical examinations and clinical tests that are specified in the control program. The regulation and the Code also place specific obligations on the examining physician.

What Provisions Are Required for Medical Examinations?

The control program must incorporate provisions for medical examinations that include:

- a medical history;
- a physical examination;
- clinical tests as described in the regulation and the Code for Medical Surveillance.

Such examinations are conducted before employment or placement of workers in jobs involving exposure to a designated substance and at periodic intervals afterwards. The control program should identify the job classifications for which, due to the nature of exposure to a designated substance, medical surveillance is required. The control program should also include a provision for the selection of the examining physician(s).

Who Should the Examining Physician Be?

The examining physician should be selected in consultation with the joint health and safety committee. The examining physician may be the company doctor, a private medical consultant contracted for by the employer, a physician on the staff of a clinic whose services are used by the employer, or the worker's own physician.

If more than one physician is involved in the medical surveillance program, it is recommended that one serve as a coordinating physician. The role of this physician should be developed on a case-by-case basis. It is suggested that he or she could assist in identifying health trends, reviewing the interpretations of medical examinations and clinical tests, maintaining records and liaising with the joint health and safety committee.

If there is a dispute between the employer and the joint committee on the selection of the examining physician(s), an inspector may be called upon to make a decision.

What Is the Purpose of the Clinical Tests?

Clinical tests are an additional indicator of the extent of a worker's exposure to the substance. They are particularly useful in cases (e.g., lead) where knowledge of airborne concentrations of the substance is insufficient, in itself, to ensure that a worker is not overexposed. Some clinical tests measure the concentration of the substance in a worker's blood or urine, thus providing an indication of the amount that has been absorbed. Others are used to measure a specific function of the body that may be affected by exposure.

Some Codes specify "action levels" for the results of clinical tests. When the test results are at these levels, action is called for, as detailed in the Code. Sometimes two action levels are specified. When the lower level is reached, the physician is required to review work practices, health status and personal hygiene. When the higher level is reached, and this result is confirmed by a second test, the worker must be removed from exposure.

The use of action levels does not mean that clinical tests are intended to be the only indicator used to protect the health of workers. The examining physician must use professional judgement in discerning other signs of possible overexposure to the substance. The tests, however, provide a safeguard mechanism in the event that other signs are not detected.

What Must the Physician Tell the Employer?

The regulations require the physician to advise the employer whether the worker is fit, fit with limitations or unfit for exposure to the substance. This determination is a professional judgement based on the results of medical examinations and clinical tests.

The examining physician must give this opinion without disclosing to the employer the results of examinations or tests.

It is recommended that each examining physician be given a copy of the assessment to help evaluate a worker's fitness for exposure.

What Else Must the Physician Report?

Some designated substance regulations require the physician to advise the committee, in writing, of the results of clinical tests, along with an opinion on how these tests should be interpreted. Others require only that the physician give the committee an opinion on the fitness of the worker for exposure. In either case, the information is confidential. If the physician has advised the employer that a worker is fit with limitations or unfit, this information must also be reported to the Provincial Physician, Ministry of Labour.

How Should the Employer and the Committee Act on Medical Information?

If the physician advises that a worker is "fit with limitations or unfit", the employer is required to act on this information. The precise action taken will depend on the professional advice of the

physician and on the requirements of the regulation and the Code. In many cases, there may be some choice concerning the course of action that can be worked out among the physician, the employer and the worker, with input by the committee.

If the results of clinical tests are at the action level for removal of the worker from exposure, then further exposure of the worker to the substance must stop until test results drop to a permissible level for return to work. Where the results of clinical tests have not reached the action level or where there is no mandatory removal level, the physician may still advise that a worker is "fit with limitations or unfit" on the basis of other signs of adverse health effects. In such a case, removal from exposure and return to the usual conditions of work are based on the judgement of the physician.

When a worker must be removed from exposure, this can be accomplished through isolation of the worker from the process or job re-assignment. Where these are not possible, temporary removal from the workplace may be necessary, and a compensation claim should be filed with the Workplace Safety and Insurance Board (WSIB).

The employer and the committee should use advice and information received from the physician to help evaluate and improve workplace controls. The information that the health of a worker has been affected by exposure to a substance or that a worker's absorption of the substance has reached an action level should always be taken as a signal that workplace controls are not operating optimally.

What Records Does the Physician Keep?

The examining physician must keep records of medical examinations and clinical tests of workers, along with the personal exposure records of the workers that have been provided by the employer. These are to be kept for 40 years from the earliest date of the records or for 20 years from the latest date, whichever is

longer. If the physician ceases to be able or willing to keep these records, they must be forwarded to the Provincial Physician, Ministry of Labour.

Who Can Get a Copy of the Records?

Copies of a worker's exposure records and the results of medical examinations and clinical tests may be given by the examining physician to the worker or the worker's personal physician on the written request of the worker. If the worker has died, the records may be released to the next of kin or the worker's personal representative, upon written request. Any other authorization by the worker for the release of the records is invalid.

Can the Records Be Computerized?

Some employers may wish to have medical records and exposure records stored in a computer system. Where a central data base is used, the physician must have access to both medical records and exposure records, and the employer or the hygienist must have access to the exposure records only. Such arrangements are acceptable provided that:

- confidentiality of medical records is maintained by using an appropriate security system;
- the physician has access to the exposure records; and
- the records are kept securely for the required period of time.

8. The Control Program - Putting It in Place

Once the control program has been developed, careful attention must be given to its implementation. Its success will hinge on the acceptance and participation of management, supervisors, workers and the joint health and safety committee.

The written control program must be given to each member of the committee and be made available in English and in the majority language of the workplace. The employer is required to acquaint every worker affected by the program with its provisions.

The following measures can help to ensure successful implementation of the control program:

1. Training programs to educate staff at all levels to the provisions of the control program. These programs should include:
   - an explanation of the health effects of the substance;
   - the rationale of the control program and the principles behind the measures chosen to control exposure;
   - specific work practices and hygiene practices that must be adhered to;
   - the duties and responsibilities of all the parties;
   - the proper use of personal protective equipment;
   - means of evaluating the effectiveness of the program;
   - communication channels through which all workers and staff can have access to those responsible for the program.

2. A tight, but realistic, schedule for implementation of each control measure. In some cases, interim control measures, such as personal protective equipment, should be provided to control exposure while more comprehensive measures are being instituted.

3. Assigning responsibility for implementing the control program to one individual to ensure effective follow-through. Separate elements of the program can subsequently be delegated to other employees. The performance of those responsible for the program should be subject to periodic review. All staff should be made aware of the individuals who are responsible for each aspect of the program.

4. An evaluation system to monitor the progress of implementation during the set-up phase and to maintain a periodic review of the continued effectiveness of control measures once they are in place. Checklists designed to aid regular inspections of controls can be a useful tool for this evaluation process. A trouble-shooting system that involves the participation of all staff is another means to maintain the effectiveness of the program.

Employers and workers needing guidance on any aspect of the designated substance regulations should contact the nearest Ministry of Labour office for assistance. A list of Ministry field offices is appended to this guide.

9. Other Information

Selected References

General Industrial Hygiene and Toxicology

Clayton, George D. and Clayton, Florence E., eds. *Patty's Industrial Hygiene and Toxicology, 4th Edition*. New York: John Wiley and Sons, 1996.

Plog, Barbara A., ed. *Fundamentals of Industrial Hygiene, Fourth Edition*. Chicago: National Safety Council, 1996.

Proctor, Nick H., Hughes, James P. and Fishman, Michael L. *Chemical Hazards of the Workplace*. Philadelphia: J.B. Lippincott Company, 1988.

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Industrial Hygiene. Occupational Health and Safety Administration, U.S. Department of Labour, 1998.

Assessments

Workbook for Designated Substance Assessments. Ontario Industrial Accident Prevention Association.

Ventilation

American Conference of Governmental Industrial Hygienists, Committee on Industrial Ventilation. *Industrial Ventilation: A Manual of Recommended Practice, 24th Edition*. Lansing, Michigan, 2001.

McDermott, Henry J. *Handbook of Ventilation for Contaminant Control, 3rd Edition*. American Conference of Governmental Industrial Hygienists (ACGIH), 2001.

Respiratory Protection

Respiratory Protection: A Manual and Guideline. Fairfax, VA: American Industrial Hygiene Association, 1993.

Respiratory Protection, Chapter 2, Section VIII, OSHA Technical Manual. Occupational Health and Safety Administration, U.S. Department of Labour, 1999.

Canadian Standards Association. Standard Z94.4-93, *Selection, Use and Care of Respirators*, 1997.

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Air Monitoring

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Sampling, Measurement Methods and Instruments, Section VIII, OSHA Technical Manual. Occupational Health and Safety Administration, U.S. Department of Labour, 1999.

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Zenz, Carl, Dickerson, O. Bruce, and Horvath, Jr., Edward P. *Occupational Medicine, 3rd Edition*. American Conference of Governmental Industrial Hygienists (ACGIH), 1994.

LaDou, Joseph. *Occupational and Environmental Medicine, 2nd Edition*. American Industrial Hygiene Association, 1997.

Organizations in Ontario's Public Occupational Health and Safety System

Ontario Ministry of Labour

Web: www.gov.on.ca/lab/main.htm

Main Office
400 University Avenue
Toronto, M7A 1T7

Occupational Health and Safety Branch
400 University Avenue, 7th Floor
Tel: 416-326-7770 / 1-800-268-8013 Fax: 416-326-7761

Publications Section
400 University Avenue, 7th Floor
Tel: 416-326-7731 / 1-800-268-8013 (ext. 6-7731)
Fax: 416-326-7745
E-mail: pubsale@gov.on.ca

Workplace Safety and Insurance Board [WSIB]

200 Front Street West
Toronto, M5V 3J1
Tel: 416-344-1000 / 1-800-387-0750 Fax: 416-344-4204
Certification Hot-Line: 1-800-268-2378
E-mail: wcbcomm@wsib.on.ca Web: www.wsib.on.ca

Safe Workplace Associations

Construction Safety Association of Ontario [CSAO]
21 Voyager Court South
Etobicoke, M9W 5M7
Tel: 416-674-2726 / 1-800-781-2726 Fax: 416-674-8866
Web: www.csao.org

Education Safety Association of Ontario [ESAO]
4950 Yonge Street, Suite 1505
Toronto, M2N 6K1
Tel: 416-250-8005 / 1-877-732-3726 Fax: 416-250-9190
Web: www.esao.on.ca

Electrical Utilities Safety Association [EUSA]
220 Traders Boulevard East
Mississauga, L4Z 1W7
Tel: 905-890-1011 / 1-800-263-5024 Fax: 905-890-9249
E-mail: eusa@eusa.on.ca Web: www.eusa.on.ca

Farm Safety Association Inc [FSAI]
340 Woodlawn Road West, Suite 22-23
Guelph, N1H 7K6
Tel: 519-823-5600 / 1-800-361-8855 Fax: 519-823-8880
Web: www.farmsafety.ca

Health Care Health & Safety Association [HCHSA]
4950 Yonge Street, Suite 1505
Toronto, M2N 6K1
Tel: 416-250-7444 / 1-877-250-7444, Fax: 416-250-9190
Web: www.hchsa.on.ca

Industrial Accident Prevention Association [IAPA]
250 Yonge Street, Suite 2800
Toronto, M5B 2N4
Tel: 416-506-8888 / 1-800-406-4272 Fax: 416-506-8880 / 1-800-316-4272
H&S Fastfax and Rulefax: 416-506-0488 / 1-800-669-4930
E-mail: feedback@iapa.on.ca Web: www.iapa.on.ca

Mines and Aggregates Safety and Health Association [MASHA]
P.O. Box 2050 (690 McKeown Avenue)
North Bay, P1B 9P1
Tel: 705-474-7233 Fax: 705-472-5800
E-mail: info@masha.on.ca Web: www.masha.on.ca

Municipal Health and Safety Association [MHSA]
220 Traders Boulevard East
Mississuaga, L4Z 1W7
Tel: 905-507-1882 Fax: 905-507-2585
E-mail: info@mhsao.com Web: www.mhsao.com

Ontario Forestry Safe Workplace Association [OFSWA]
P.O. Box 2050 (690 McKeown Avenue)
North Bay, P1B 9P1
Tel: 705-474-7233 Fax: 705-474-4530
E-mail: info@ofswa.on.ca Web: www.ofswa.on.ca

Ontario Service Safety Alliance [OSSA]
4950 Yonge Street, Suite 1500, The Madison Centre
Toronto, M2N 6K1
Tel: 416-250-9111 / 1-888-478-6772 Fax: 416-250-9500
E-mail: info@ossa.com Web: www.ossa.com

Pulp and Paper Health and Safety Association [PPHSA]
P.O. Box 2050 (690 McKeown Avenue)
North Bay, P1B 9P1
Tel: 705-474-7233 Fax: 705-472-5800
E-mail: info@pphsa.on.ca Web: www.pphsa.on.ca

Transportation Safety Association of Ontario [TSAO]
555 Dixon Road, Suite 101
Rexdale, M9W 1H8
Tel: 416-242-4771 / 1-800-263-5016 Fax: 416-242-4714
Web: www.tsao.on.ca

Occupational Health Clinics for Ontario Workers Inc. [OHCOW]

Web: www.ohcow.on.ca

Co-ordinator's Office
15 Gervais Drive, Suite 202
Toronto, M3C 1Y8
Tel: 416-443-6314 Fax: 416-441-0772
E-mail: rwareing@ohcow.on.ca

Hamilton Clinic
848 Main St. West, Hamilton, L8M 1L9
Tel: 905-549-2552 / 1-800-263-2129 Fax: 905-549-1993
E-mail: hamilton@ohcow.on.ca

London Clinic
380 Adelaide St. North, Suite 3, London, N6B 3P6
Tel: 519-432-3535 Fax: 519-642-7834
E-mail: ldwhc@execulink.com

Sarnia Clinic
225 Mitton St. North, Sarnia, N7T 6H5
Tel: 519-337-4627 Fax: 519-337-9442
E-mail: sarnia@ohcow.on.ca

Sudbury Clinic
1780 Regent St. South, Times Square Mall,
Sudbury, P3E 3A8
Tel: 705-523-2330 / 1-800-461-7120 Fax: 705-522-8957
E-mail: sudbury@ohcow.on.ca

Toronto Clinic
15 Gervais Dr., Suite 308, Don Mills, M3C 1Y8
Tel: 416-449-0009 / 1-888-596-3800 Fax: 416-449-7772
E-mail: toronto@ohcow.on.ca

Windsor Clinic
547 Victoria Ave., Windsor, N9A 4N1
Tel: 519-973-4800 / 1-800-565-3185
E-mail: windsor@ohcow.on.ca

Workers' Health and Safety Centre [WHSC]

15 Gervais Drive, Suite 102, Don Mills, M3C 1Y8
Tel: 416-441-1939 / 1-888-869-7950 Fax: 416-441-1043
E-mail: Postmaster@whsc.on.ca Web: www.whsc.on.ca

Canadian Centre for Occupational Health and Safety [CCOHS]

250 Main Street East, Hamilton, L8N 1H6
Health and Safety Inquiries: 1-800-263-8466 [Canada only]
Customer Service: Tel: 905-570-8094 / 1-800-668-4284 [Canada and US]
Customer Service: Fax: 905-572-2206
E-mail: custserv@ccohs.ca Web: www.ccohs.ca

Regulations made under the *Occupational Health and Safety Act* Revised Statutes of Ontario, 1990, Chapter O.1 as amended.

February 1, 2001

A. Safety Regulations

Construction Projects:	O. Reg. 213/91, as amended by O. Reg. 631/94, O. Reg. 143/99, O. Reg. 571/99, O. Reg. 145/00, and O. Reg. 527/00.
Industrial Establishments:	R.R.O. 1990, Reg. 851, as amended by O. Reg. 516/92, O. Reg. 630/94, O. Reg. 230/95, O. Reg. 450/97, O. Reg. 144/99, O. Reg. 284/99, and O. Reg. 528/00.
Mines and Mining Plants:	R.R.O. 1990, Reg. 854, as amended by O. Reg. 583/91, O. Reg. 584/91, O. Reg. 171/92, O. Reg. 384/92, O. Reg. 571/92, O. Reg. 693/92, O. Reg. 60/94, O. Reg. 779/94, O. Reg. 68/96, O. Reg. 272/97, O. Reg. 236/99 and O. Reg. 486/99.
Window Cleaning:	R.R.O. 1990, Reg. 859, as amended by O. Reg. 523/92.
Critical Injury Defined:	R.R.O. 1990, Reg. 834.
Training Requirements for Certain Skill Sets and Trades:	O. Reg. 572/99.
Diving Operations:	O. Reg. 629/94.
Firefighters—Protective Equipment:	O. Reg. 714/94, as amended by O. Reg. 449/97.
Health Care and Residential Facilities:	O. Reg. 67/93 as amended by O. Reg. 142/99.
Oil and Gas—Offshore:	R.R.O. 1990, Reg. 855.
Roll-Over Protective Structures:	R.R.O. 1990, Reg. 856.
Teachers:	R.R.O. 1990, Reg. 857.
University Academics and Teaching Assistants:	R.R.O. 1990, Reg. 858.

B. Designated Substances

Acrylonitrile:	R.R.O. 1990, Reg. 835, as amended by O. Reg. 507/92.
Arsenic:	R.R.O. 1990, Reg. 836, as amended by O. Reg. 508/92.
Asbestos:	R.R.O. 1990, Reg. 837, as amended by O. Reg. 509/92, O. Reg. 598/94 and O. Reg. 386/00.

Asbestos on Construction Projects and in Buildings and Repair Operations:	R.R.O. 1990, Reg. 838, as amended by O. Reg. 510/92.
Benzene:	R.R.O. 1990, Reg. 839, as amended by O. Reg. 511/92 and O. Reg. 387/00.
Coke Oven Emissions:	R.R.O. 1990, Reg. 840, as amended by O. Reg. 512/92.
Ethylene Oxide:	R.R.O. 1990, Reg. 841, as amended by O. Reg. 515/92.
Isocyanates:	R.R.O. 1990, Reg. 842, as amended by O. Reg. 518/92.
Lead:	R.R.O. 1990, Reg. 843, as amended by O. Reg. 519/92 and O. Reg. 389/00.
Mercury:	R.R.O. 1990, Reg. 844, as amended by O. Reg. 520/92 and O. Reg. 390/00.
Silica:	R.R.O. 1990, Reg. 845, as amended by O. Reg. 521/92 and O. Reg. 391/00.
Vinyl Chloride:	R.R.O. 1990, Reg. 846, as amended by O. Reg. 522/92 and O. Reg. 392/00.

C. General

Biological or Chemical Agents, Control of Exposure to:	R.R.O. 1990, Reg. 833, as amended by O. Reg. 513/92, O. Reg. 597/94 and O. Reg. 388/00.
Hazardous Materials Inventories:	R.R.O. 1990, Reg. 850, revoked by O. Reg. 397/93.
Workplace Hazardous Materials Information System:	R.R.O. 1990, Reg. 860, as amended by O. Reg. 36/93.

D. Hazardous Physical Agents

X-Ray Safety:	R.R.O. 1990, Reg. 861.

E. Regulations that Directly Affect/Impact the Act

Training Programs:	O. Reg. 780/94.
Unilateral Work Stoppage:	O. Reg. 243/95.
Inventory of Agents or Combinations of Agents for the Purpose of Section 34 of the Act:	R.R.O. 1990, Reg. 852, as amended by O. Reg. 517/92.
Joint Health and Safety Committees—Exemption from Requirements:	O. Reg. 385/96, as amended by O. Reg. 131/98.

NOTE:

For a complete reference to the Regulations made under the *Occupational Health and Safety Act*, please see the Annual Consolidated Index to the Regulations of Ontario.

Guides to Occupational Health and Safety Legislation

A Guide to the Occupational Health and Safety Act.

A Guide for Joint Health and Safety Committees and Representatives in the Workplace.

Designated Substances in the Workplace: A General Guide to the Regulations.

A Guide to Acrylonitrile.*

A Guide to Benzene.*

A Guide to Isocyanates.*

A Guide to Lead.*

A Guide to Mercury.*

A Guide to Silica.*

(*Each of these guides works in conjunction with "A General Guide to the Regulations").

A Guide to the Asbestos Regulation for Construction Projects, Buildings and Repair Operations.

A Guide to Roll-Over Protective Structures (ROPS).

A Guide to Window Cleaning.

Workplace Hazardous Materials Information System (WHMIS): A Guide to the Legislation.

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For inquiries please contact the Ministry of Labour office nearest to you. Consult the blue pages in your local telephone directory for additional information.